Yamaha DPX-1 Digital Cinema Projector

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A DLP Projector For Home Theatre

The Yamaha DPX-1 is a Digital Light Processing (DLP(tm)) projector designed from the ground up for home theatre applications. Unlike many business presentation projectors that are sold to the home entertainment market, Yamaha engineers addressed several crucial home theatre performance issues in the DPX-1. Improvements include darker blacks, less fan noise, and premium quality deinterlacing and scaling. The result is a video projector that delivers an outstanding large-screen viewing experience.

Appearance

According to its brochure, the DPX-1 has a pearl-mica exterior. If you don't have an official Yamaha color chart, I would describe that as an attractive platinum or silver satin finish. The projector is a compact 16 3/8 x 5 1/8 x 16 5/8 inches (WHD), and extremely lightweight at just over 17 pounds. That's ideal for hanging from a ceiling, or concealing in a table between your favorite rocker chairs. It's so quiet and easy to set-up, you could even haul it out of a closet and place it on a table whenever you want to enjoy a movie. But I expect anyone with a DPX-1 will use it so often they will want it permanently installed.

The projector's single-lens optics are recessed into the case, which protects against fingerprints, or more serious accidental damage. It's easy to adjust the picture size to fit the screen and focus the image using the manual zoom and focus rings, which are accessible through an opening in the top cover. Of course, you never have to adjust convergence or a myriad of geometry controls, which makes installation and maintenance a snap compared to a CRT projector.

Set Up

The DPX-1 can be used in a front projection or a rear projection configuration, hung from a ceiling or placed on a table below the screen. The optimum vertical distance from the center of the lens to the top (or bottom) of the screen depends on the screen size, which also determines the throw distance to the screen. The DPX-1 manual provides the necessary throw distances and mounting heights for both 4:3 (1.33:1) and 16:9 (1.78:1) screens. The zoom lens permits a range of throw distances for a specific screen size. For a 100-inch diagonal, 16:9 screen, the throw distance is 14 feet, 5 inches to 17 feet, 5 inches and the optimum mounting height is 20 7/8 inches below

the screen. But the DPX-1 includes a Digital Lens Shift feature and Digital Keystone Correction, which allows the mounting height in this example to vary from 12 5/8 inches to 29 1/8 inches below the screen and still achieve excellent results.

Technology
The DPX-1 utilizes Texas Instruments' single-chip DLP(tm) technology. The light source is a 120W projection lamp that shines through a rotating color wheel. During each video frame the color wheel filters the light into red, green, and blue components that sequentially reflect off a Digital Micromirror Device (DMD) and through the single projection lens.

The heart of the DLP system is Texas Instruments' Digital Micromirror Device, an optical semiconductor chip with a 1024 x 768 array of hinged mirrors that are electrostatically deflected to reflect light toward or away from the lens. The DMD is electrically driven by individual RGB signals synchronized with the color wheel segments to sequentially produce the three primary color components of each frame image. Persistence of vision integrates the three primary images into a full-color picture. The DMD used in the Yamaha projector is a 0.9-inch device to increase light output, while some earlier projectors used 0.7-inch DMDs. The DMD is rated for a service life of more than 100,000 hours.

The DPX-1 uses a tri-segment color wheel with red, green, and blue segments. It does not have the white (transparent) segment found in projectors that were originally designed for business presentations. A transparent segment increases the maximum light output, which is important for computer presentations in bright rooms, but decreases the contrast ratio for video. The tri-segment color wheel improves the black level and the contrast ratio.

I must note that the color wheel technology used by all consumer-priced DLP projectors relies on persistence of vision to integrate the sequential red, green, and blue images into a single full-color picture. When viewers blink their eyes, sometimes in combination with eye movement, color separation artifacts may become momentarily visible as rainbow-colored edges, or a short horizontal streak containing red, green, and blue segments. There seems to be dramatic differences in perceptual sensitivity to this effect amongst viewers-which may be related to an individual's normal blink rate and eye movement. I've had guests that never see the effect, while others are significantly annoyed. I suggest that you audition and ascertain your own sensitivity and tolerance for the color separation effect when considering a DLP projector.

Contrast Ratio
Yamaha claims a full on/off contrast ratio of 900:1. With all the image controls set at their factory calibrated positions, I measured a peak white level of 22.4 foot-Lamberts (ft-L) at the plane of an 80-inch wide, 16:9 screen, and a black level of 0.03 ft-L on a completely black frame. That indicates a full on/off contrast ratio of about 750. But when I recalibrated the gray scale tracking for better accuracy, the light level in the

black frame fell below the 0.03 ft-L sensitivity of my colorimeter, without reducing the peak white level. Since a black level of 0.025 ft-L yields a contrast ratio of 900:1, it appears Yamaha's specification can be achieved in normal use.

This is stellar performance for a fixed-pixel projector, and I noticed the improvement right away. The black bars in letterboxed movies, and the ring of leakage light around the screen, are darker than what I have seen from many fixed-pixel projectors. It is still highly desirable to surround the screen with non-reflective black masking, but the lower black level makes effective masking easier.

Gamma Correction

Gamma correction is necessary in any non-CRT projector because video signals are precompensated for the approximately 2.2-2.6 gamma inherent in CRTs. Many fixed-pixel projectors designed for boardrooms do not have accurate video gamma correction, which can badly distort a picture's gray scale and near-black shadow detail. The DXP-1 has 13-bit Digital Gamma Correction processing. The middle (3) of five selectable gamma curves appears correct for video. The four other gamma correction curves can be used with other input sources, such as a computer, or may be useful with video in non-optimum ambient lighting conditions.

Connections

The DPX-1 has a wide array of analog video inputs including composite video, S-video, and two inputs for YPbPr or RGB component video. The component video inputs include a VGA-style, 15-pin D-sub connector, and 5-BNC jacks for YPbPr or RGB component video with HV or composite sync. The component video inputs are specified to accept interlaced 480i video, 480p from a progressive DVD player or line doubler, 720p or 1080i HDTV video, or computer (VGA, SVGA, XGA or SXGA) standards.

I used an AccuPel HDTV Calibration Generator (www.accupel.com) to verify that the RGB and YPbPr inputs were compatible with both 1080i and 720p HDTV formats. The RGB input worked perfectly with positive or negative HV sync, and the YPbPr component video input worked with Bi-level or Tri-level embedded sync.

There is also a digital RGB DVI connector and a special D-connector for components with the Japanese D1-D4 formats.

An RS-232 serial connector is included on the input panel. But according to the manual it is used for factory testing only, and is not available for a computer or advanced theater controller. There is also a +12V output to trigger a motorized screen when the projector is powered on.

Control
The DPX-1 can be controlled from a row of buttons located across the top of the rear panel, or from the remote control. The buttons on the rear panel, and most of the buttons on the remote control, are lighted for operation in a dark room. They remain illuminated for about 10 seconds after any one of them is pushed, or when a dedicated button is depressed on the side of the remote. The rear panel buttons mirror the essential features of the remote control. They include an Input button that produces an on-screen menu to select an input signal source, and a Pattern button to select built-in test patterns. There is also a Menu button, Up/Down/Left/Right cursor buttons, an Escape (exit) button, and a Select button for using the on-screen menus.

The rear panel also includes a Standby/ On button, a Lamp indicator, and a Temperature/Fan indicator. Yamaha recommends that the projection lamp be replaced after 1,000 hours of use. The Lamp indicator begins flashing when the lamp usage exceeds 1,000 hours, which is also accompanied by an on-screen message that can be deleted by the user. The Lamp indicator flashes faster at 1,100 hours, or if the lamp burns out. The lamp is priced at $599 and is easily replaceable by the user. The temperature indicator lights when the internal temperature becomes excessive, or flashes if the fan is out of order.

The DPX-1 includes inverse-telecine processing to optimally deinterlace film-source video from 480i interlaced sources. A blue 24p indicator on the rear panel lights whenever the projector detects the 3:2 pulldown cadence of film-source video.

The remote control has the same pearl-mica finish of the projector. It fits comfortably in one hand and features an easy-to-use joy-disc that functions as both Cursor and Select buttons to navigate the on-screen menus. There are Pattern and Input buttons that duplicate the rear panel functions. But there are also six buttons to directly select any one of the inputs. It was impressive to find this feature on the remote because reviewers are forever complaining about products that force us to cycle through inputs. Apparently Yamaha has heard these complaints, or have engineers that actually use their own products. In the same spirit, the remote control includes six dedicated buttons to directly recall the six memories that store image-processing settings.

The remote control also provides a Still (freeze) feature and a hide function-the latter turns off the picture. Finally, there is a Reset button that returns any menu item to the factory default setting.

Aspect Ratio Modes
The DPX-1 has six selectable Aspect Ratio modes. When a 16:9 screen is used, the Normal mode displays a 4:3 picture in the horizontal center of the screen. The Squeeze mode displays 16:9 (anamorphic) DVDs. The Zoom mode fills the screen width when 4:3 letterbox images are displayed. There is also a Zoom Subtitle mode, for which I found little use.

There are two modes, Through and Through-Squeeze, that display 4:3 and 16:9 formats respectively, without horizontal scaling. Normally when a 16:9 screen is used, the center 1024 x 576 pixel area of the 1024 x 768 pixel DMD chip is used. In the Through mode, a 480i input is projected using only the center 640 x 480 pixel region to produce a 4:3 aspect ratio without any vertical scaling of the input signal. This makes the displayed picture smaller than the Normal mode, but avoids all vertical scaling artifacts. In the Through-Squeeze mode, the horizontal width of the picture is set to produce a 16:9 image for 16:9 (anamorphic) formats, but the vertical pixels are still not scaled.

The last Aspect Ratio Mode is called Auto. It detects information embedded in the vertical blanking interval of some DVDs and sets the aspect ratio to Normal, Squeeze, or Zoom as appropriate. When 720p or 1080i HDTV sources are input, the projector always displays a 16:9 aspect ratio. When PC signals are input through the RGB (or DVI) connector, all of the Aspect Ratio modes except Auto are available.

On-Screen Menus

The on-screen menus are some of best-formatted and easiest to use that I have seen. The Menu Window can be positioned anywhere on the screen, which gets it out of the way while adjusting the image processing functions. There are four menu groups: Image, Signal, Setup, and Initial that can be selected from the menu bar to fill the window.

The Setup and Initial menus are primarily used when installing the projector. The Initial menu provides selections that are usually set and forgotten, including the Color System (NTSC, PAL, etc), Menu Language, a Power Saving feature, and the type of video signals connected to Input A and B-the two component video inputs. The latter choices are YPbPr, RGB TV, or RGB PC. The lamp running time can also be checked or reset in the Initial menu.

The Setup menu is used to select the Screen Aspect ratio and the Installation orientation (ceiling or table mount, front or rear projection). There is a Digital Lens Shift function to center a 16:9 image vertically on screen by moving it within the 4:3 pixel array of the DMD chip. This provides some latitude in the mounting height of the projector. Two types of Digital Keystone Correction are provided to compensate for trapezoidal distortion created by mounting the projector at a non-optimum height relative to the screen. This feature worked perfectly.

The Image and Signal menus can be used to alter the picture parameters on specific source material, or to set up individualized parameters for each input. The Image menu provides Contrast, Brightness, Color Saturation, and Hue functions. These were accurately calibrated from the factory at the "0" default settings. The Color control is unusual because it is only applicable to composite and S-video signals. A separate Color Boost adjustment allows color saturation to be increased for YPbPr signals (including HDTV) but not reduced. There is also a separate Black Level adjustment. The Black Level control functions the same way most Brightness adjustments do on other dis-

plays, and in this instance is accurately named. It varies the black level without changing the peak white level. The Brightness adjustment changes the overall brightness of the entire video signal range.

The Image menu includes the five-position Gamma Trim adjustment, which is most accurately set at the midrange (3) default position for video. There is also a five-position Sharpness control that provides both vertical and horizontal edge-enhancement. I would suggest leaving it at the minimum setting (1) for most source material. Edge-outlining artifacts become apparent as it is advanced, but some users may find a modest amount of edge-enhancement useful on a few extremely soft DVD transfers, or older TV programs.

The Image menu also includes four Color Temperature selections and a White Balance function to re-calibrate the grayscale color temperatures. The White Balance function provides a submenu with Contrast (Gain) and Brightness (Bias) controls for each of the red, green, and blue primary colors.

The Signal menu provides selections to adjust Aspect Ratio, Subtitle Masking, Noise Reduction, Video Type (VCR or Other), 3-D Y/C separation (for composite video signals), and Setup Level (0 or 7.5 IRE). The noise reduction feature is only available for standard-definition interlaced sources. The setup level can be turned on or off for 480i, 480p, 720p, and 1080i signals.

All of the Image menu items plus settings for Noise Reduction, Video Type, the 3-D Y/C Filter, the Setup Level, and the Aspect Ratio are stored in six memories, which can be recalled from the six dedicated memory buttons on the remote control.

The Image menu items can also be individually displayed at the bottom of the screen, out of the way of calibration patterns, by pressing the select button when no other menus are being displayed. Each press displays the next picture adjustment item from the Image menu. This feature demonstrates that Yamaha's engineers were paying excellent attention to the home theatre application in designing this projector.

Deinterlacing And Scaling

The Digital Micromirror Device in the DPX-1 has a 1024 x 768 pixel array arranged in a 4:3 aspect ratio. When displaying a 16:9 frame on a 4:3 screen, or when using a 16:9 screen, 1024 x 576 pixels are used for the 16:9 image. All incoming video signals must be scaled by the projector to fit within that pixel array. A 4:3 picture in the center of a 16:9 screen will use a 768 x 576 pixel array, which is just a little larger than the native 720 x 480 resolution of a DVD frame. The built-in scaler will convert all incoming signals formats to 576p, which means 480i and 480p formats are upconverted, while 1080i and 720p HDTV formats must be downconverted.

Before 480i signals can be scaled, they must first be converted from interlaced to progressive video. The DPX-1 has inverse-telecine deinterlacing to optimally convert 480i signals to 480p. Many fixed-pixel projectors, originally designed as presentation projectors, do not include inverse-telecine processing, and therefore require an external line doubler or scaler to produce acceptable video performance.

Inverse-telecine processing provides artifact-free deinterlacing of film-source video as long as the video processor can lock onto the 3:2 field pulldown cadence that results from transferring 24 frame-per-second film to 60 field-per-second interlaced video. The DPX-1 did an excellent job deinterlacing the many DVD movies I viewed. It also performed without any glitches on the Video Essentials Montage sequence, which switches back and forth between film-source and video-camera source material.

It is much more difficult to deinterlace original interlaced video that does not have 3:2 pulldown. There are no ideal algorithms for this type of deinterlacing. The usual network programming looked excellent, but the most difficult test is action sports. I could see some jaggies and line twitter as a camera panned the lines on a soccer field, but the artifacts were quite minor and unlikely to distract most viewers. To achieve any better performance would require an external scaler with advanced video-source deinterlacing algorithms, such as Faroudja's Directional Correlation Deinterlacing (DCDi).

Unless you are looking for the ultimate in video-source deinterlacing, I don't see any reason to use an external scaler with the DPX-1. The performance of its internal scaler is excellent, with no obvious artifacts or picture softening whether upconverting standard definition formats or downconverting HDTV formats.

Resolution

The image resolution of a fixed-pixel projector is limited by the size of the native pixel array, and sometimes by scaling or deinterlacing incoming signals. I used the AVIA Guide To Home Theater resolution wedge test patterns to check resolution with 480i input signals. The DPX-1 displayed the full vertical and horizontal resolution limits of the DVD format for both S-video and YPbPr signals. The vertical lines in the 6.75 MHz circle showed some visual aliasing, but this is well beyond the practical horizontal resolution limit of real DVDs. S-video signals produced somewhat less response (less modulation depth) in the 6.75 MHz lines, and at the limit of the horizontal resolution wedge. The AVIA Sharpness pattern also showed that YPbPr signals produced visibly sharper edges on fine lines than S-video.

The 1024 x 576 pixel resolution for 16:9 frames does limit the resolution of HDTV signals. Single pixel-wide black and white lines from an AccuPel HDG-2000 multiburst pattern are not visible on either 1080i (1920 lines per picture width) or 720p (1280 lines/PW) signals. A two pixel-wide burst was badly aliased at 1080i (960 lines/PW) and still showed some aliasing at 720p (640 lines/PW). The three-pixel wide burst at 1080i (640 lines/PW) also revealed some visual aliasing.

In actual practice, the DPX-1 produces superb pictures from real HDTV picture sources, which shows how much more demanding the sharp lines of test patterns are than actual video images. High-definition movies were often spectacular in clarity and detail, and generally far surpass DVD movies in definition. In part this reveals that DVD images seldom take advantage of the format's maximum resolution. But even the best DVD transfers are no match for the average HBO-HD movie broadcast by DirecTV. Aliasing is seldom obvious on these movies, because bandwidth limitations smooth the finest details and camera movement is often minimal. Aliasing becomes more apparent when viewing demo material shot with high-definition video cameras. Some of the most demanding demo scenes include fly-over helicopter shots of rocky coastlines and high-rise buildings in cities. The detail and movement in these images will reveal the resolution limitations of fixed-pixel projectors. Nevertheless, I found most viewers hardly notice these artifacts until they see A/B comparisons with a high-resolution CRT projector.

Other Measurements

I measured the factory Color Temperature settings (Low, Mid-L, Mid, and High) as 5080K, 5860K, 6670K, and 8160K on a 75 IRE window using a 1080i HDTV calibration signal. The gray scale measured 6500K, +380/-485 K at the Mid setting. I used the White Balance feature to recalibrate the grayscale to 6500K, +235/-350 K from 20 to 100 IRE for the MID setting.

The green primary color was visibly shifted more toward yellow than the standard SMPTE-C or Rec. 709 HDTV primary color. The accompanying CIE diagram shows a narrowing of the color gamut along the blue-green side of the color triangle. This reduces the saturation of blue-green colors and eliminates extremely deep greens, which can be observed in landscapes and the grassy playing fields of outdoor sporting events. However, the standard-definition YPbPr color decoding still produces excellent color accuracy within the DPX-1 color gamut. The complementary yellow, magenta, and cyan colors are quite close to the standard SMPTE-C colors in the CIE diagram. As a result flesh tones and other colors within the color triangle are quite accurate.

Overscan varied depending on the incoming video signal format. With 480i YPbPr signals, overscan was an almost uniform 3 percent on the top, bottom, left, and right edges of the picture. With an S-video input, overscan varied from about 2.5 to 4 percent on the four edges. In the HDTV formats, the overscan varied from 2 to 5 percent in the 1080i RGB TV mode, but was a nearly uniform 4 percent using YPbPr signals. When the DPX-1 was set to RGB PC mode, it produced less than 2 percent overscan for the 1080i RGB HDTV format.

I noticed one anomaly using 1080i YPbPr or RGB signals. Standard signal levels were clipped at a maximum white level below 98 IRE. Changing the Contrast setting, or other image controls, had no effect on the clipping level. This is virtually unnoticeable on pictures from a set-top box that produces standard SMPTE HDTV signal levels. But the RCA DTC-100 HD Satellite Receiver produces signals larger than the SMPTE

standard, which resulted in signal clipping just below 90 IRE. Unless you have the means to properly attenuate the RGB signals, that receiver should not be used with the DPX-1 until Yamaha corrects this problem.

Low Noise Cooling System

Fan noise can be an overwhelming distraction in a home theatre, and a surprisingly difficult problem to fix in a front projection system. This issue has been aggressively addressed in the design of the DPX-1. Cool air enters through filtered intake slots on the rear panel, and is exhausted through a special sound absorbing chamber on the front of the projector. Yamaha specifies the noise level as only 30 dB, and it is indeed the quietest DLP or LCD projector that I have evaluated. The noise level fell below the 50 dB sensitivity limit of my sound level meter only one foot from the air intake port at the rear, and inches from the sides of the projector. Yamaha recommends cleaning the air filters after every 200 hours of operation. There is also an extra filter included with the projector.

Visual Observations

The most outstanding quality of the DPX-1 is the improved black level for a fixed-pixel projector. This significantly enhanced picture performance in nearly every movie I watched on DVD or HDTV. The key to a better picture is lowering the absolute light level of black. This also greatly improves the contrast ratio, but it is the lower absolute brightness of black that allows subtle shadow details to be revealed, and removes much of the haze that covers dark night scenes. The black level is just below 0.03 ft-L on an 80" wide 16:9 screen, so there is still room for further improvement. But for the first time I could enjoy watching extremely dark movies like The Game and Dark City on a fixed-pixel projector. Scenes in space from movies such as 2001: A Space Odyssey and The Fifth Element are dramatically enhanced. Space is black, and dark gray approximations do not deliver the beauty or stark coldness of the universe beyond our atmosphere.

The new, vastly improved transfer of 2001:A Space Odyssey is a marvelous DVD to watch on the DPX-1. The scene on the moon at the monolith site demonstrates the full contrast range of the projector, with brilliant whites and excellent shadow details throughout the picture. The spacecraft scenes reveal the vivid colors and full DVD resolution of the projector. Another DVD that looks stunning on the DPX-1 is Austin Powers: The Spy Who Shagged Me. The colors are brilliant with peak light levels more than twice my CRT projector. Even with the highly-saturated colors in the 60's scenes, the flesh tones are accurately rendered.

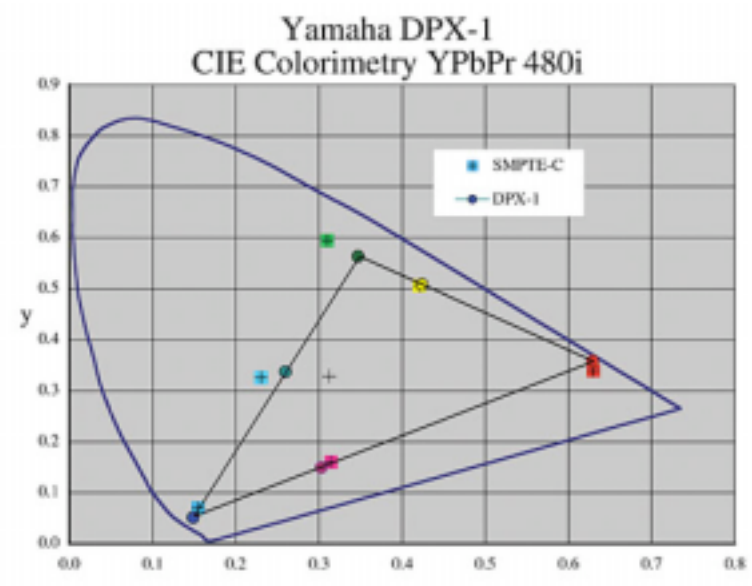
The new video release of Thirteen Days provides an excellent example of the outstanding DVD picture definition of the DPX-1. The Cabinet Room scenes are filled with detail right down to the fine stripes on the white shirt of Dean Acheson. The excessive edge-enhancement added to the outdoor Cuban scenes is clearly distinguished from the minimal edge-enhancement during most of the Oval Office scenes. The black and white segments demonstrate the excellent white field uniformity of the DPX-1.

High-definition movies looked marvelous on the DPX-1. There is more than enough resolution to easily reveal the superior definition of HDTV movies compared to the best DVDs. I watched a variety of HBO-HD movies and demo loops on DirecTV, as well as CBS-HD programming and HD-demo loops from my local NBC and PBS affiliates. My vote for best looking high-definition actress goes to Julia Roberts in I Love Trouble, broadcast on the HBO-HD channel by DirecTV. Image clarity was excellent and color details far beyond the chroma resolution of DVDs were prominently displayed. But the best looking HDTV movie that I watched on the DPX-1 was the Jamie Foxx film Bait, which had extraordinary clarity. Simulated computer screens of text information were so crisp and well defined it was like watching the projector driven directly by a PC. Throughout the movie fine details and textures were outstanding. There were also many dark night scenes that were rendered with excellent contrast.

There were many more HBO-HD movie offerings that looked terrific, including The Thirteenth Floor. But the most outstanding HDTV picture belonged to The Tonight Show With Jay Leno on NBC. The images captured by HDTV video cameras currently eclipse the best HD movie sources in resolution. The backdrop behind Leno on the new Tonight Show set is a spectacular collage of brilliant colors and fine structure that looked superb on the DPX-1.

Summary

The Yamaha DPX-1 is an outstanding new DLP projector specifically designed for large-screen home theatres. It includes an excellent built-in video scaler with inverse-telecine deinterlacing, which eliminates the expense of purchasing an external scaler. Yamaha has significantly improved the DLP black level and contrast, which greatly enhances picture quality with all standard-definition and HDTV sources. They have also dramatically reduced fan noise, which effectively improves the audio performance of your home theatre.



Specifications:
DPX-1 Specifications
Projection System: Digital Light Processing(DLP(tm)) technology
Panel: 0.9 inch XGA DMD(tm) x 1
Resolution: 1,024 x 768 pixels
Brightness: 800 ANSI lumens
Contrast Ratio: 900:1 (Full on/off)
Projection Lens: 1:1.2 manual zoom, manual focus
Light Resource: 120 W P-VIP lamp
Projection Distance: 1.2-10.6 m (3' 9' - 35')
Image Size: 25"-200" for 16:9 picture
Video Standard: NTSC, PAL, NTSC4.43,SECAM, PAL60, PAL_M and PAL-N
Input Accepted: SDTV(480i, 576i), HDTV(480p, 720p, 1080i),
DVD component progressive or interlaced, TV/Satellite tuner, VCR, SXGA(compression), XGA, SVGA and VGA
Horizontal Sync Range: 15-80 kHz
Vertical Sync Range: 50-85 Hz
Power Consumption: 185 W

Dimensions (WHD In Inches): 16.375 x 5.125 x 16.625
Weight: 17.2 pounds
Pricing:
DPX-1 - $9999
DPX-1 Mounting Brackets
PMT-L11 - For low ceilings $299.00 MSRP
PMT-H-15 - For high ceilings $499.00 MSRP
DPX-1 Projection Lamp PJL-L112 - $599.00 MSRP

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